A revision of *Reophax* and its type-species, with remarks on several other Recent hormosinid species (Protozoa: Foraminiferida) in the Collections of the British Museum (Natural History)

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I. The genus *Reophax* de Montfort, and its type species *R. scorpiurus* de Montfort

(a) The taxonomic status of the genus *Reophax* de Montfort

De Montfort (1808 : 331) introduced the genus *Reophax* ('Réophage; en latin, Reophax') as the 83rd genus of his conchiological system of classification, with the type-species, *Reophax scorpiurus* de Montfort ('Le Réophage queue de scorpion'). It was designated apparently on the basis of a single specimen illustrated by Soldani (1795 : pl. 162, fig. K), one of his 'corpuscula maris dubia et incerta', contained in 'vas 319' from the Mediterranean. Soldani (*op. cit.* : 239) had written of figs I and K of pl. 162 . . . 'Quae supersunt reliqua I, & K mihi ignota prorsus sunt, nisi fortasse K ad Orthoceratis speciem aliquam pertineat . . .', and it is clear that he was unable, at the time, to place either specimen within his system, hence they are described under the heading (p. 209): 'Classis Tertia. Sistens Testacea Bivalvia, Frumentaria, Dubia ac Zoophyta. Cui additur Supplementum Analysim continens marini sedimenti'.

The genus *Reophax* is defined by de Montfort (1808 : 331) as . . . 'Coquille libre, univalve, cloisonnée; droite, sinuée et insectée, ou offrant plusieurs étranglemens, les concamérations augmentant de volume avec l'âge; bouche terminale, arrondie; siphon central'. On the same page de Montfort continues with a description of the type-species which he illustrates on the opposite page (p. 330) with a copy in rather stylized form (and upside-down) of Soldani's original figure. He writes . . . 'Rangé parmi les coquilles droites, il est cependant un peu sinueux, mais point tors. Ses chambres sont séparées les unes des autres par autant d'étranglemens qui rappellent ceux des insectes, en donnant à leur ensemble l'aspect de la queue d'un scorpion. Elles deviennent successivement plus grandes, singulièrement quadrillées, et on ne peut mieux les comparer qu'à autant de petites lanternes hexagones, enfilées les unes aux autres. Elles sont toutes traversées par un siphon qui leur est commun, et qui partant de la base où il sert de bouche, va se rendre au sommet'.

At first sight it seems that de Montfort possessed no material of *R. scorpiurus* of his own as he writes (*loc. cit.* : 332) . . . 'C'est sur la confiance que nous inspire Soldani que nous avons publié cette coquille cloisonnée, qui se trouve dans les sables de la mer Adriatique; ce savant laborieux, doué d'une patience extraordinaire, avoit réuni dans de petits vases des millions de coquilles microscopiques qu'il décrivoit; il avoit su trier et séparer chaque espèce, et dès-lors au milieu de tant de points de comparaison, on ne peut lui contester les formes qu'il publia'. However, in the next paragraph he adds a remark on the colour of the test . . . 'Lorsque le réophage queue de scorpion est encore frais dans ses teintes, il présente celles

orangées; exposé au soleil il se décolore, et d'autrefois il prend un ton ocracé. Il a quelquefois une demi-ligne de longueur', an observation which does not occur in Soldani's work, and may be taken to imply that de Montfort had his own collection. In an attempt to shed light on this possibility, one of us (P. B.) wrote to Mme Y. LeCalvez in Paris, inquiring of the whereabouts of a 'De Montfort Collection', and in particular *R. scorpiurus*. She replied (letter dated 21 : 6 : 77) that it is not in the Museum of Natural History, Paris, nor does anyone seem to know what has happened to it and therefore must be presumed lost. This fate must also be assumed for Soldani's collection.

De Montfort's description of *Reophax* and its type-species conform to the International Code of Zoological Nomenclature and are taxonomically valid. Nevertheless, much is missing from the original definition or is of a confusing nature. Nothing is said, for instance, about the constitution of the wall in *R. scorpiurus*, an omission which may either reflect the fact that de Montfort had not examined specimens at first hand, or, as is more likely, was because the taxonomic significance of wall texture was not at that time recognized. An uncertainty also exists concerning the 'siphon central' which is said to be common to, and to traverse all the chambers. If this is not just a generalization, it could indicate a condition found in *Ginesina* Bermúdez & Key, a subglobular-chambered genus in which the apertural necks are rather long and, if preserved in succeeding chambers, give the impression of a continuous siphon. *Ginesina* was placed in synonymy with *Reophax* by Loeblich & Tappan (1964 : 216). The form and position of the aperture of *R. scorpiurus*, on the other hand, were clearly defined by de Montfort as rounded and terminal; nothing was said about the presence or absence of a neck.

Parker & Jones (1860 : 10) in their critique of 'The Foraminifera enumerated by Denys de Montfort' unfortunately shed little light on the problem . . .

'61. Vol. i, p. 330. 83^{e} genre. Reophax Scorpiurus. Soldani, Testaceogr. pl. 162, fig. K. This is a uniserial and, as it were, abortive variety of the arenaceous *Lituola nautiloidea*, and is of world-wide distribution in shelly deposits. Soldani's figure, true as to outline, fails to exhibit the sandy texture of the shell. De Montfort fancifully exaggerates the angularities of the segments of Soldani's drawing into doubly crossed chambers, "singulièrement quadrillées".

D'Orbigny refers the *Reophax* of De Montfort (under the terms "Réophage" and "Reophagus") to the Nodosariae in several of his notices of the synonyms of *Nodosaria'*.

From this historical résumé it is therefore not surprising that many discrete species, both fossil and Recent, have subsequently been referred to *Reophax scorpiurus* and that the true identity of the species is uncertain. Furthermore, the genus *Reophax* itself is in great need of revision. Recently, several authors, in particular Seiglie & Bermúdez (1971 : 221), have advocated that both *Reophax* and its type-species should be declared *nomina dubia*. However, in view of the fact that these names have been so much used in the literature, it is here proposed, in the interests of nomenclatorial stability, to redefine the genus on the basis of a neotype for *R. scorpiurus*.

(b) A neotype for *Reophax scorpiurus* de Montfort

According to de Montfort (1808 : 332) *R. scorpiurus* came from the Adriatic Sea, in sand. We have therefore examined a number of samples and faunal slides in the collections of the British Museum (Natural History) from beach sands of the Adriatic, for specimens of a *Reophax* which would best fit the figure of Soldani (1795 : pl. 162, fig. K) and the description of de Montfort. A neotype was finally chosen from a shallow water sample collected by H. Sidebottom off Corfu. Our thanks must go to Mr R. V. Melville, International Commission of Zoological Nomenclature, for his guidance in the choosing of this neotype, which is in keeping with Article 75 of the Code.

Reophax scorpiurus de Montfort
Figs 1–7, 12, 17

NEOTYPE. ZF 3985. From Corfu, S.E. Adriatic, shallow water. Heron-Allen & Earland 'Students' Collection', ex Sidebottom Collection. Figured by scanning electron microscopy in Figs 2, 5.

PARANEOTYPES. 12 specimens, three of which (ZF 3986–3988) are figured (Figs 1, 3, 4, 6, 7, 12, 17). From type-locality.

DESCRIPTION (NEOTYPE). Test free, uniserial; elongate and slender, slightly curved in lateral view, irregularly rounded in apertural view. Chambers four in number and rapidly increasing in size; overlap onto preceding chambers only slight. Early chambers more or less cylindrical, final one somewhat bulbous and ventricose, that is more rounded and wider on the inner side of the curvature of the test than on the outer side. Transverse sutures well defined, not oblique. The bulbous, ventricose ultimate chamber tapers gradually to its terminal and rounded aperture which is not produced. In course of ontogeny, position of aperture becomes more and more eccentric in respect to ventricose side of the chamber. Wall agglutinated, single-layered and imperforate, made up of relatively large angular quartz grains embedded in a clear, finely granular cement. Although the quartz grains surrounding the aperture are smaller than in the wall in general, the apertural rim remains rather coarsely textured.

DIMENSIONS (NEOTYPE). Length of test 700 μm. Chamber lengths from initial to ultimate: 100, 100, 150 and 350 μm; respective widths: 80, 120, 120 and 200 μm.

VARIATION (PARATYPES). Three of the 12 paraneotypes are illustrated by scanning electron microscopy in Figs 1, 3, 4, 6, 7, 12 and 17. The overall morphology is as described for the neotype, the tests closely resembling the scorpion's tail appearance of the specimen illustrated by Soldani (1795) and de Montfort (1808). Both 4 and 5-chambered forms occur, the lengths of the tests ranging between 550 and 1000 μm, about 700 to 800 μm being the average. In some paraneotypes the ventricose asymmetry of the final chamber is more distinct (e.g. Figs 3, 7) than in others.

REMARKS. The ventricose asymmetry seen in the final chamber and the absence of a produced aperture, as developed in *Hormosina*, are both important criteria in the generic definition of *Reophax*. These features are also well shown by the specimen from the Campos Shelf, Brazil, which although not as slender as the type-specimens, comes close to, and has been placed into *R. scorpiurus* (see Brönnimann, 1980, t-fig. 2, figs 1, 2). Many records of *R. scorpiurus,* however, are not conspecific with our type material. The specimen figured by Brady (1884, pl. 30, fig. 12) as *R. scorpiurus*, for instance, although possessing an asymmetric final chamber tapering to a terminal rounded aperture, has a much larger and more robust test with more voluminous chambers. It is described below as *Reophax bradyi* sp. nov. Also Loeblich & Tappan's (1964 : 216, fig. 128, 1) *R. scorpiurus* from the Gulf of Mexico is not conspecific with the neotype, and instead comes very close to *R. bradyi.* Cushman's (1920 : 6, pl. 1, fig. 7) specimen of *R. scorpiurus* from Albatross Stn. D2531 in the N. Atlantic, is probably a correct identification; he notes (p. 7) that the ... 'early chambers (are) more or less indistinct, irregularly arcuate, later ones larger and more distinct, nearly in a straight line ....', but his later descriptions (1920, 1933 and 1940) include straight tests which belong to other hormosinid genera. It is beyond the scope of this paper to review critically all the very many references to *R. scorpiurus* in the literature. Most would, however, seem to be incorrect, based as they are on the wide concept of the species adopted by Brady (1884, pl. 30, figs 12–17) and subsequently by Cushman, and bear little relationship to the original description. Care must now be taken in assigning specimens to this taxon.

In view of the morphology shown by the neotype of *R. scorpiurus* and the foregoing discussion, the following emended diagnosis of *Reophax* is proposed.

(c) Emendation of the genus *Reophax* de Montfort

Family **HORMOSINIDAE** Haeckel, 1894

Genus ***REOPHAX*** de Montfort, 1808, emended Brönnimann & Whittaker, herein

1795 *Orthoceras* ? Bruguière; Soldani : 239
1808 *Reophax* de Montfort : 331
1826 *Nodosaria* Lamarck; d'Orbigny : 255
1858 *Proteonina* Williamson : 1
1860 *Lituola* Lamarck; Parker & Jones : 10
1874 *Silicina* Bornemann : 731
1887 *Reophaxopsis* De Folin : 127

The genera, *Ginesina* Bermúdez & Key, 1952 (type-species *G. delicatula*) and *Nodulina* Rhumbler, 1895 (type-species *Reophax dentaliniformis* Brady, 1881), synonymised with *Reophax* by Loeblich & Tappan (1964 : 216), are transferred to *Hormosina* (see below, p. 265).

EMENDED GENERIC DEFINITION. Test free, elongate, arcuate, consisting of a single series of chambers which normally increase in size during ontogeny and overlap to some degree onto the preceding chambers. Initial portion at least is incurved or early chamber arrangement suggests curvature. Adult chambers subglobular, cylindrical or pyriform, rounded or somewhat compressed in transverse section, asymmetric in side view, ventricose, heteropolar, devoid of internal structures, infolds of wall, and siphon. Wall agglutinated, single-layered, imperforate. Aperture terminal, subcircular, oval to elongate-oval.

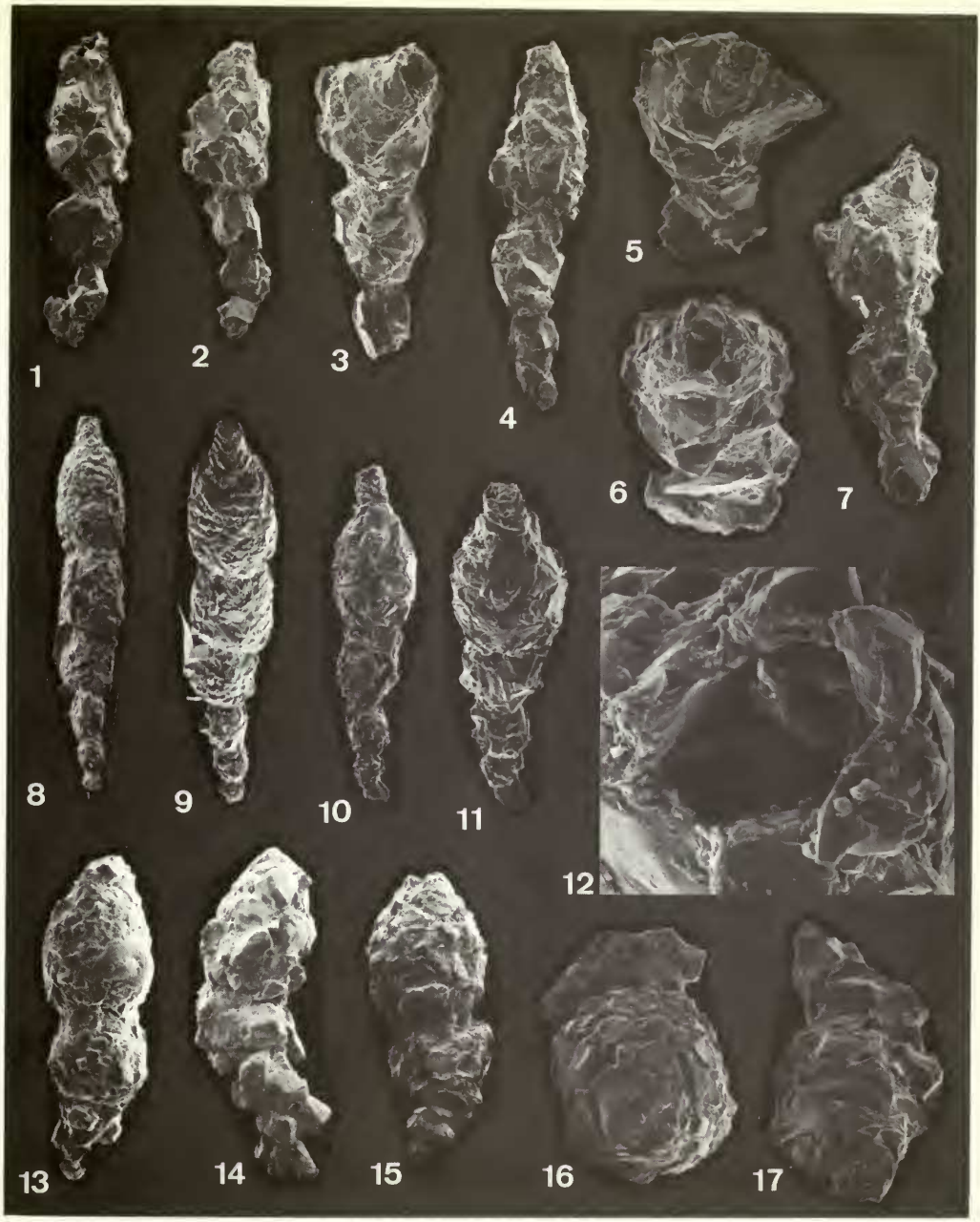
TYPE-SPECIES. *Reophax scorpiurus* de Montfort. Recent. Adriatic Sea.

REMARKS. The test of the genus *Reophax*, as emended above, differs from that of *Hormosina* (Brady, 1879) in having an incurved early portion and ventricose asymmetry of the adult chambers as seen in lateral view. The type-species of *Hormosina*, *H. globulifera*, originally described by Brady from deep waters of the Atlantic and Pacific Oceans, is characterised by linearly arranged (occasionally irregularly disposed), globular, thin-walled, smooth-surfaced chambers (or rarely a single chamber) and a rounded terminal aperture produced on a distinct neck; the chambers, furthermore, are radially symmetrical. The generic differentiation between *Reophax* and *Hormosina* has in the past been unclear. It was dealt with by Brady (1884 : 325) when he wrote that . . . 'The genus *Hormosina* comprehends the moniliform section of the Trochamminae and occupies the same position in the group that *Reophax* takes amongst the rougher Lituolidae. Under ordinary circumstances, there is no difficulty in distinguishing the Hormosinae from their larger Lituoline isomorphs, by their thin walls and smooth, almost homogeneous tests, and amongst the smaller species by their regularity and symmetry of form'. Brady, however, still placed forms with radially symmetrical chambers in *Reophax* (a typical species being *R. dentaliniformis* Brady), whereas, work by one of us (Brönnimann, 1980) on Recent radially-symmetrical 'reophaxes' from the Campos Shelf of Brazil, has shown that Brady's criteria cannot be used in all cases to separate the two genera. Instead, the ventricose chamber asymmetry and initial curvature of the test, features highlighted in our emended generic diagnosis of *Reophax* (discussed further on p. 266, below), are much more reliable parameters. Wiesner (1931 : 89) arrived at similar conclusions to ourselves, but in spite of his observations, he still used the consistency of the wall as his main distinguishing feature.

As both *Ginesina* Bermúdez & Key (1952) and *Nodulina* Rhumbler (1895) have straight, linear tests and radially-symmetrical chambers, they are synonymized with *Hormosina*, instead of *Reophax* as was proposed by Loeblich & Tappan (1964 : 217).

Proteonina fusiformis Williamson, type-species of *Proteonina* (Williamson, 1858), from the Recent of Skye, was originally shown in side view (*op. cit.*, pl. 1, fig. 1) to possess an

Figs 13–16 *Reophax bradyi* sp. nov. Fig. 13, Paratype (ZF 3993), side view. Fig. 14, Paratype (ZF 3994), side view. Figs 15, 16, Paratype (ZF 3995); side and oblique–apertural views. Fig. 13, from off Cronlin (?Crawlin) Island, Hebrides, N.W. Scotland, *Challenger* Collection. Figs 14–16, both from Heron-Allen & Earland Students' Collection, Mediterranean. Fig 13, 14, × 26; figs. 15, × 22; fig. 16, × 42.



Figs 1–7, 12, 17 *Reophax scorpiurus* de Montfort. Figs 2, 5, Neotype (ZF 3985); side and oblique-apertural views. Figs 1, 6, 12, Paraneotype (ZF 3986); side, oblique-apertural and detailed apertural views. Figs 3, 7, Paraneotype (ZF 3987); oblique-apertural and side views. Figs 4, 17, Paraneotype (ZF 3988); side and oblique-apertural views. All from Heron-Allen & Earland Students' Collection, Corfu, E. Mediterranean. Figs 1–4, 7, × 60; figs 5, 6, × 110; fig. 12, × 530; fig. 17, × 95.

Figs 8–11 *Hormosina dentaliniformis* (Brady). Figs 8, 9, Lectotype (ZF 3990); side and oblique-apertural views. (Specimen illustrated by Brady, 1884, pl. 30, fig. 21). Figs 10, 11, Paralectotype (ZF 3991); side and oblique-apertural views. Both from *Challenger* station 300, north of Juan Fernandez Island, E. Pacific. Fig. 8, × 25; fig. 9, × 30; fig. 10, × 42; fig. 11, × 54.

asymmetric ventricose ultimate chamber which gradually tapers to a rounded terminal aperture without a neck; the chamber is round in transverse section. There is some controversy as to whether this specimen is monothalamous or is subdivided. Williamson's figure does not appear to show sutures, but Loeblich & Tappan's (1955 : 7, pl. 1, figs 2, 3) lectotype, together with a specimen illustrated from Norway and referred by Höglund (1947, pl. 4, fig. 21) to this species, clearly do. After re-examining Williamson's material we have no hesitation in stating that *Proteonina* is a junior homonym of *Reophax*.

The genus *Sulcophax* Rhumbler (1931, *in* Wiesner) (type-species *S. claviformis*), from deepwater off Antarctica, is characterised by a linear test, heteropolar chambers and a sulcus-like depression across the terminal face in which an elongate apertural slit is situated. It is accepted as being distinct from *Reophax* by Loeblich & Tappan (1964 : 217, figs 128, 8a, b). Its chambers, although rounded in transverse section, are not radially symmetric, but through the development of a sulcus, dissymmetric. Hence, *Sulcophax*, though possessing a straight linear test, cannot be placed in *Hormosina* and is distinct.

Glaucoammina Seiglie & Bermúdez (1969), type-species *Reophax trilateralis* Cushman, from the Caribbean shelf seas, differs from *Reophax* in having a completely enrolled early stage. *Oblidolina* Brönnimann & Whittaker gen. nov., type-species *Reophax arcticus* Brady, from Arctic waters, lacks the incurved initial curvature of the test as seen in *Reophax* and is strongly laterally compressed (see p. 267, below).

Finally, there are certain Recent hormosinid species, previously referred to *Reophax*, such as *R. scotti* Chaster from shallow water off the coasts of the British Isles, which exhibit an ordered, tile-like arrangement of the quartz flakes making up the single-layered, imperforate wall (see Murray, 1971 : 17, pl. 1, figs 7, 8). The order in which the wall is constructed might be taxonomically significant at generic level, but at present there exists no comparative study of hormosinid wall textures which considers this potentially important criterion.

II. Some recent Hormosinid species in the collections of the British Museum (Natural History)

(a) On *Reophax bradyi* Brönnimann & Whittaker sp. nov.

Reophax bradyi sp. nov.
Figs 13–16

1884 *Reophax scorpiurus* de Montfort; Brady : 291 (*pars*), pl. 30, figs 12a, b, only. (*non* de Montfort, 1808).
1894 *Reophax scorpiurus* de Montfort; Goës : 24 (*pars*), pl. 6, figs 164–166 only.
1964 *Reophax scorpiurus* de Montfort; Loeblich & Tappan : 216, figs 128, 1.

DIAGNOSIS. A large, robust 4–6 chambered species of *Reophax* with inflated chambers throughout, Early portion of test curved, coarsely agglutinated, last two chambers straight, usually with finer agglutinant.

HOLOTYPE. ZF 3992. Off Cronlin (?Crawlin) Island, Hebrides, N.W. Scotland. *Challenger* Collection, ex Brit. Mus. (Nat. Hist.) slide no. ZF 2286. Specimen figured by Brady (1884, pl. 30, figs 12a, b), not re-illustrated in this paper.

DESCRIPTION (HOLOTYPE). Test uniserial, initially curved, later straight, composed of 6 chambers which increase rapidly in size, the last two chambers making up more than half of the test. Final chamber distinctly asymmetric in side view and ventricose (side which lies outside curvature of the test, almost straight, that on the inside, curved); early chambers more or less cylindrical. Sutures well defined, transverse, with little overlap of the chambers. Aperture terminal rounded and flush, rim made up of large angular quartz grains. Wall single layered and apparently imperforate, consisting of rather large angular quartz grains which are cemented by a very little light brownish organic material. Early chambers more coarsely agglutinated than final ones. Test overall yellow-brown in colour.

DIMENSIONS (HOLOTYPE). Maximum length of test 2100 μm; maximum length and width of final chamber 900 and 650 μm, respectively; maximum length of initial chamber 150 μm.

VARIATION (PARATYPES). A 5-chambered paratype (ZF 3993) from the type-locality is illustrated in Fig. 13. Its initial portion is only slightly curved but the final chamber shows the same ventricose aspect as the holotype. The initial portion is very coarsely agglutinated with angular quartz grains. The early portion is almost colourless, the later chambers are light yellowish. Its dimensions are: maximum length of test 1800 μm; maximum length and width of final chamber, respectively 900 and 600 μm. Two other paratypes, ZF 3994 and ZF 3995 are also figured. They are from Mediterranean waters (Siddall Collection) and have a similar morphology and dimensions to the Hebridean material.

REMARKS. The citations of Brady (1884), Goës (1894) and Loeblich & Tappan (1964) have probably been most widely used as a basis for *Reophax scorpiurus* in the literature. As none of them are conspecific with the neotype of de Montfort's species as described above, a new species is proposed to clarify the situation. Other specimens in the *Challenger* Collection referred by Brady to *R. scorpiurus* (e.g. Brady, 1884, pl. 30, figs 13–17), by their overall morphology and agglutination of the wall, belong neither to *R. scorpiurus* s.s. nor to *R. bradyi* and need further study beyond the scope of this paper.

(b) On *Hormosina dentaliniformis* (Brady)

Brady (1881 : 49) described this species as . . . 'a small, delicate variety of *R. scorpiurus*, but more slender and regular in contour . . .', but he did not illustrate it. In the Challenger Report (1884 : 293)he refers to it as a '*Dentalina*-like modification of *Reophax scorpiurus*', adding that . . . 'its home is on the deep sea-bottoms, and out of twenty-one stations at which its presence has been noted, only four have a depth of less than 1000 fathoms, whilst seven are above 2000, and two above 3000 fathoms'. He illustrates two specimens without defining a holotype. In this paper the opportunity is taken to choose a lectotype, and to re-describe and illustrate the species.

Family HORMOSINIDAE Haeckel, 1894

Genus ***HORMOSINA*** Brady, 1879

TYPE-SPECIES: *Hormosina globulifera* Brady, 1879. Recent. Atlantic and Pacific Oceans.

Hormosina dentaliniformis (Brady)
Figs 8–11

1881 *Reophax dentaliniformis* Brady : 49.
1884 *Reophax dentaliniformis* Brady; Brady : 293, pl. 30, figs 21, 22.

LECTOTYPE. ZF 3990. From *Challenger* station 300, north of Juan Fernandez Island, E. Pacific, depth 1,375 fathoms (2,515 m), ex Brit. Mus. (Nat. Hist.) slide no. ZF 2265. Figured by scanning electron microscopy in Figs 8, 9; originally illustrated by Brady, 1884, pl. 30, fig. 21.

DESCRIPTION (LECTOTYPE). Test long, slender and tapering, consisting of 6 pear-shaped or cylindrical chambers arranged more-or-less in a straight line and rapidly increasing in size, separated by rather indistinct transverse sutures. In side view, chambers are radially symmetrical, heteropolar and have little overlap onto the preceding ones, ultimate chamber tapering gradually into a distinct neck which is produced and has a rounded terminal aperture; in transverse section, chambers rounded. Agglutinant consists of large angular and rounded grains of quartz, with black, yellow and brown mineral grains; cement white.

DIMENSIONS (LECTOTYPE). Length of test 2050 μm. Chamber length, from initial to ultimate, 150, 200, 250, 300, 450 and 700 μm; respective widths, 110, 150, 220, 350, 350 and 400 μm. Length of apertural neck 150 μm, outside diameter of aperture 120 μm.

VARIATION (PARALECTOTYPES). The figured paralectotype (ZF 3991), one of a group of 24 specimens from slide ZF 2265, N of Juan Fernandez, is 1060 μm long. Lengths of individual chambers from initial to ultimate, are 50, 100, 170, 230 and 510 μm. The maximum diameter of the final chamber is about 290 μm and that of the rounded aperture, including the thick wall, is 70 μm. The length of the tubular apertural neck is 140 μm. The specimen is very similar in morphology to the lectotype, but has five chambers and is much smaller. The remainder of the paralectotypes vary in length between 700 and over 2000 μm and the number of chambers varies from two to six. Other specimens in the Museum collections from *Challenger* dredgings both in the Atlantic and Pacific, show very little morphological variation.

REMARKS. The rectilinear test, radial symmetry of the chambers and produced apertural neck clearly place this species in *Hormosina*, rather than in *Reophax* as redefined above. The new genus *Nodulina*, proposed for this species by Rhumbler (1895), is unnecessary.

(c) *Oblidolina* Brönnimann & Whittaker gen. nov.

Family **HORMOSINIDAE** Haeckel, 1894

Genus ***OBLIDOLINA*** gen. nov.

GENERIC DEFINITION. Test free; viewed laterally, elongate, tapering, consisting of a single series of chambers arranged in a straight line and which normally increase in size as added and overlap to some degree on the preceding ones; viewed aperturally, elongate-ovate in shape. Postembryonic chambers strongly compressed in edge view; radially asymmetric, heteropolar, devoid of inner structures, infolds of the wall, and siphon. Wall agglutinated, single layered, imperforate. Aperture terminal, oval to lozenge-shaped in outline, may be slightly produced.

NAME. *Oblido*, latin, to squeeze together. It refers to the highly compressed nature of the test.

TYPE-SPECIES. *Reophax arcticus* Brady, 1881. Arctic Sea.

REMARKS. The agglutinated wall of the genera *Reophax*, *Hormosina* and *Oblidolina* is single layered and imperforate. The chemical composition of the organic substance in which the agglutinant is incorporated and the degree of order in which it is arranged, are not considered in this purely morphological classification. Once the taxonomic significance of these criteria is better understood it may be possible to introduce a more refined system than that proposed here. Because the constitution of the wall is more or less the same throughout the Hormosinidae, the three genera reviewed in this paper are differentiated by gross morphological features as follows.

The primary feature of taxonomic importance is the radial symmetry or asymmetry of the adult chambers in respect to the axis of growth. Radial or monaxial heteropolar symmetry in the sense of Hyman (1940 : 19), here applied to chamber organization, occurs in *Hormosina*. Asymmetry or bi-radial symmetry or dissymmetry in the sense of Hyman (1940 : 19, 20) are seen in *Reophax*, *Sulcophax* and in *Oblidolina*, where the longitudinal axes of the adult chambers are heteropolar.

The second ranking element is the lateral compression of the postembryonic chambers. It is present throughout the test of *Oblidolina*, and normally absent in *Reophax*, but occasionally the ultimate chamber may show slight lateral compression. This lateral compression does not occur in *Hormosina*, although Höglund (1947 : 92) mentioned that *Reophax nanus* Rhumbler, which we would refer to *Hormosina*, may show a slight compression. Haynes (1973 : 22) also described specimens of *H. nana* (as *Reophax arctica* Brady) from Cardigan Bay, Wales, as 'slightly compressed'.

The initial curvature of the test is the third classificatory feature in order of importance. The initial portion of *Reophax* is always incurved to some degree. *Hormosina* and *Oblidolina* are represented by straight or almost straight tests, devoid of any initial curvature.

Normally, the generic determination of a given species does not pose any problems. However, if one of the three critical features listed above is not well developed, or ambiguously developed—such as the ventricose asymmetry of the adult chamber(s) in certain species of *Reophax*, or where a slight compression of a chamber may occur in a few species of *Hormosina*—then problems might arise concerning the generic assignment of the species. If whole populations are considered such problems do not occur.

The apertural features, in particular the form of the opening, whether it is produced or not, or contained in a sulcus or not, as well as details of the chamber form (but *not* concerned with symmetry or asymmetry), and the number of chambers, etc., enter only in the diagnosis of the species.

(d) On *Oblidolina arctica* (Brady)

Apart from *Hormosina nana* (Rhumbler), *Oblidolina arctica* (Brady) is probably the most frequently recorded hormosinid species from Arctic waters. It was first described by Brady (1881*a* : 405, pl. 21, figs 2a, b) under the name of *Reophax arctica*, as . . . 'Test elongate, tapering, often more or less irregular, compressed, only slightly constricted at the septal lines. Segments numerous; septation indistinct; aperture simple; wall arenaceous, very thin. Length 0·3 millim.'. The material came from the Austro-Hungarian North Polar Expedition, where it was said (*op. cit.* : 405) to be . . . 'an exceedingly minute and obscure species, which may be regarded as a sandy isomorph of *Lingulina*. With the exception of a single specimen from Station 504, and one which had been previously recorded, without a specific name, from Capt. Markham's soundings, all the specimens are from Station 503, so that the distribution appears confined to the Novaya Zemlya Sea'.

Oblidolina arctica (Brady)
Figs 18–32

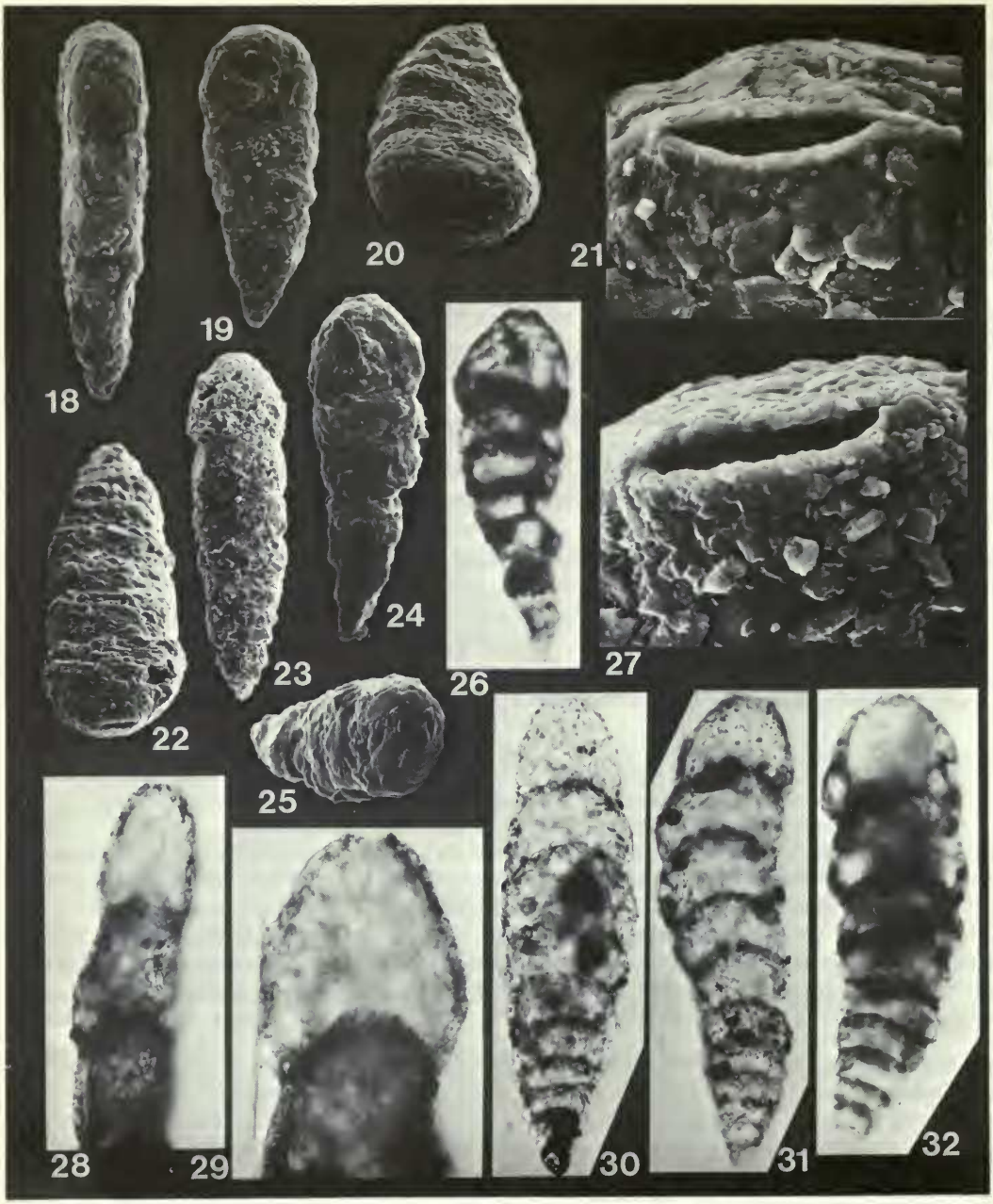
1881*a* *Reophax arctica* Brady : 405, pl. 21, figs 2a, b. (English version).
1882 *Reophax arctica* Brady; Brady : 11, pl. 2. figs 2a, b. (German translation).
?1929 *Bigenerina delicatula* Cushman & Kellett : 3 (*pars*), pl. 1, figs 5a, b only.
?1952 *Reophax arctica* Brady; Parker : 395, pl. 1, figs 6, 7.
non 1957 *Reophax arctica* Brady; Boltovskoy : 18, pl. 3, figs 1–4.
non 1973 *Reophax arctica* Brady; Haynes : 22, pl. 3, figs 8–12; pl. 6 figs 4, 5, 7.
1978 *Reophax arctica* Brady; Schafer & Cole : 29, pl. 2, fig. 5.

LECTOTYPE. ZF 3996. From Austro-Hungarian North Polar Expedition station 503, off Novaya Zemlya, Arctic Ocean, lat. 76°25′N, long. 62°43′E, depth 70 fathoms (130 m), ex. Brit. Mus. Nat. Hist. slide no. 1955.101.714–715. Figured by scanning electron microscopy in Figs 18–21.

DESCRIPTION (LECTOTYPE). Test wedge-shaped in side and edge view, made up of a tapering linear series of 9 chambers of which the final three make up about half the test; in apertural view, elongate-ovate with rounded peripheries. Proloculus subglobular; remaining chambers distinctly compressed, dissymmetric or bilaterally symmetric, heteropolar, not radially symmetric (excepting possibly the proloculus), and at least the adult chambers wider than high. Transverse sutures straight, indistinct in the early portion of the test, but well defined later on. Overlap of chambers very small. Aperture, a lozenge- or diamond-shaped elongate slit produced only slightly. Agglutinated wall rather smooth, single-layered and imperforate. Agglutinant a fine-grained groundmass in which larger quartz grains and flakes are incorporated; there is very little organic cement. Colour or test, brownish-grey.

DIMENSIONS (LECTOTYPE). Length of test 300 μm. Length, width and thickness of final chamber, respectively 80, 100 and 70 μm. Diameter of proloculus 20 μm. Respective length and width of aperture, 40 and 7 μm.

VARIATION. The paralectotype (ZF 3998) shown in Figs 24, 25, also comes from the Brit. Mus. Nat. Hist. slide no. 1955.101.714–715, from the type-locality. It is 260 μm in length.



Figs 18–32 *Oblidolina arctica* (Brady). Figs 18–21, Lectotype (ZF 3996); edge, side, oblique-apertural and detailed apertural views. Figs 22, 23, 27–29, ZF 3997; oblique-apertural, side and detailed apertural views; edge and side views of final chambers in immersion oil. Figs 24, 25, Paralectotype (ZF 3998); side and oblique-apertural views. Figs 26, 30–32, side views of four topotypes in immersion oil. Figs 18–21, 24, 25, both from Austro-Hungarian North Polar Expedition, station 503, Novaya Zemlya (U.S.S.R.), Arctic Ocean. Figs 22, 23, 27–29, from the Restigouche River, New Brunswick, E. Canada, material donated by Dr C. T. Schafer. Figs 26, 30–32, all from Austro-Hungarian North Polar Expedition, station 503, Naturhistorisches Museum, Vienna, slide no. 1978/1953. Fig. 18, × 185; fig. 19, × 150; fig. 20, × 210; fig. 21, × 925; fig. 22, × 220; fig. 23, × 160; figs 24, 25, × 190; fig. 26, × 360; fig. 27, × 1450; fig. 28, × 250; figs 29, 31, × 340; fig. 30, × 370; fig, 32, × 400.

In the Naturhistorisches Museum, Vienna, there exists a further slide prepared by Brady, with 12 additional paralectotypes from Austro-Hungarian North Polar Expedition station 503. As photography or preparation of this material was not allowed, Dr F Rögl kindly provided the authors with ten topotypic specimens picked out of the original sample (Naturhistorisches Museum, Vienna, slide no. 1978/1953). All these topotypes are compressed, but the degree of compression is variable. Irregularities of growth are expressed either by a slight curvature of the test or by sudden changes in the size and shape of a chamber, or both. Five of the topotypes were placed in a clearing medium and four of them photographed in transmitted light are illustrated in Figs 26, 30–32. They show that the ultimate chamber is invariably wider than it is high and its periphery, as seen in edge and apertural views, is rounded. The proloculus is subglobular with a very thin wall less than 1 μm thick, of clear brownish appearance, almost devoid of agglutinant. In lateral view, the position of the aperture, slightly produced and on average about 20 μm in length, is suggested by a flattening of the terminal portion of the final chamber. The walls of the test are thin, not more than 5 μm thick in the final chamber and agglutinated by rather large quartz flakes and dark mineral grains; there is only very little organic cement. The agglutinant, though consisting of relatively large components, appears to be distributed in such a way that it produces a rather smooth surface which is light grey in colour. The dimensions of the five topotypes, measured in oil, are given below, together with those of the lectotype for comparison.

Specimen	Length of test	Diameter of proloculus including the wall	Final chamber Width	Final chamber Length	No. of chambers
Topotype 1	200 μm	30 μm	80 μm	40 μm	7
Topotype 2	270	20	65	50	9
Topotype 3	230	?	70	55	?11
Topotype 4	180	20	80	40	8
Topotype 5	250	10	80	50	11
Lectotype	300	20	100	80	9

Dr C. T. Schafer, Bedford Institute of Oceanography, Dartmouth, Canada, has sent us a number of specimens determined by him as *Reophax arcticus* Brady from the Restigouche River, New Brunswick, Canada. They are very similar in overall morphology to the lectotype, paralectotypes and topotypes from station 503, Novaya Zemlya, in that they are distinctly compressed and exhibit a somewhat serrated outline in side view; the tests are also occasionally, tortuous or slightly curved and show the growth irregularities first mentioned by Brady (1881*a*). Their colour is grey brown and the agglutinant contains numerous dark mineral grains. One of the specimens has been illustrated by scanning electron microscopy in Figs 22, 23, 27, whilst another was photographed in clearing oil and is shown in Figs 28, 29. The dimensions of seven specimens from the Restigouche River, measured in oil, are given below. An asterisk denotes the proloculus is missing.

Specimen	Length of test	Diameter of proloculus including the wall	Final chamber Width	Final chamber Length	No. of chambers
1	400 μm	20 μm	80 μm	50 μm	12
2	675	25	100	110	15
3	325	20	70	60	10
4	220	—	90	50	9*
5	300	—	80	65	9*
6	265	15	95	50	10
7	295	15	75	60	11

The individual listed as specimen no. 2 refers to a very long, tortuous test with a final growth stage of 3 chambers which are smaller than the preceding ones and almost equidimensional when seen in lateral view. Measured edgeways it has a maximum thickness of 70 μm against a lateral width of 100 μm. The elongate aperture is 25 μm long and about 15 μm wide. In specimen no. 3 the widest chamber is not the final one but the 9th chamber with a width of 90 μm. This tendency in larger individuals to produce smaller final chambers has not been observed in the type-material.

REMARKS. Because the highly compressed, almost straight test, with radially asymmetric chambers, does not correspond to *Reophax s.s.*, as redefined, nor readily to any other hormosinid genus, our new genus *Oblidolina* is justified.

Although commonly recorded from Arctic and both North and South Atlantic waters (see Haynes, 1973), many records are in error and now need careful comparison with the lectotype. For this reason our synonymy is restricted to selected references which are discussed herein.

Possibly the specimen described and illustrated by Cushman & Kellett (1929 : 3, pl. 1, figs 5a, b) from the west coast of South America, as the 'Adult. Uniserial stage' of *Bigenerina delicatula* Cushman & Kellett, may be *Oblidolina arctica*. It shows the same compressed uniserial test and lozenge-shaped aperture and is quite clearly different from the biserial test of *B. delicatula*. The specimens determined by Parker (1952 : 395, pl. 1, figs 6, 7) as *Reophax arctica* may be conspecific. However, nothing is said in her description about the compression of the test nor is the edge view illustrated, and without seeing her original material it is impossible to be certain. One of us (P. B.) has examined the specimens from the mouth of the Río de la Plata, Argentina, determined by Boltovskoy (1957 : 18, pl. 3, figs 1–4) as *R. arctica*. In transverse section the chambers are usually rounded, however, although the adult chambers may sometimes show a slight lateral compression. The aperture is rounded to oval in shape and only slightly produced and is quite unlike that of *Oblidolina arctica*. We are of the opinion that they probably belong to *Hormosina nana* (Rhumbler). They are illustrated by scanning electron microscopy with further comments in Brönnimann (1980, t-fig. 6, figs 3–5, 11, 13–15, 17, 18).

Material

The material illustrated in this paper, with the exception of the specimens (1978/1953) returned to the Naturhistorisches Museum, Vienna, are housed in the collections of the Protozoa Section, Department of Palaeontology, British Museum (Natural History), registered numbers ZF 3985–ZF 3998 inclusive.

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